SunLab Molten-Salt Thermal Storage Tests

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Team Members:

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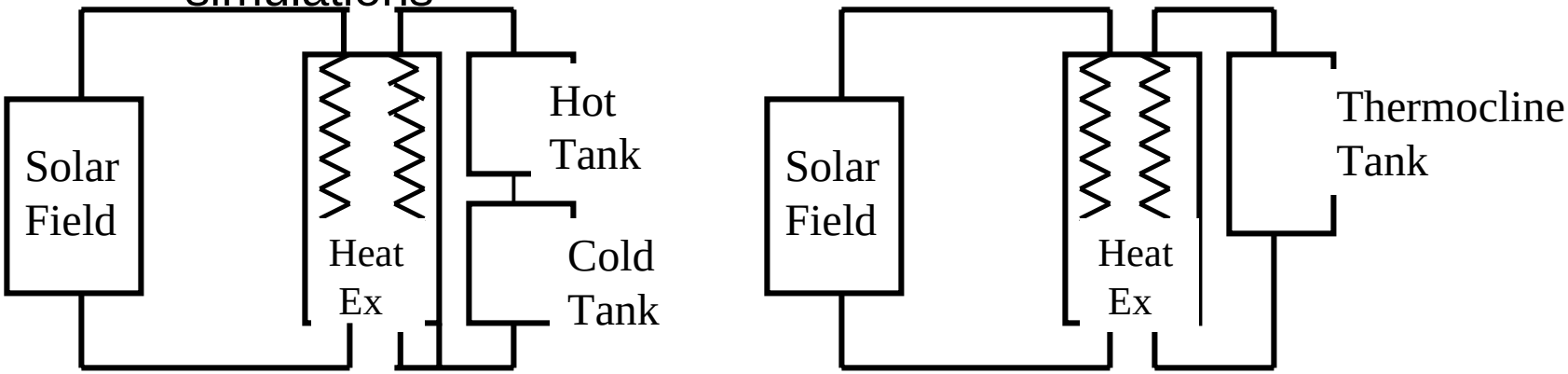
Approach

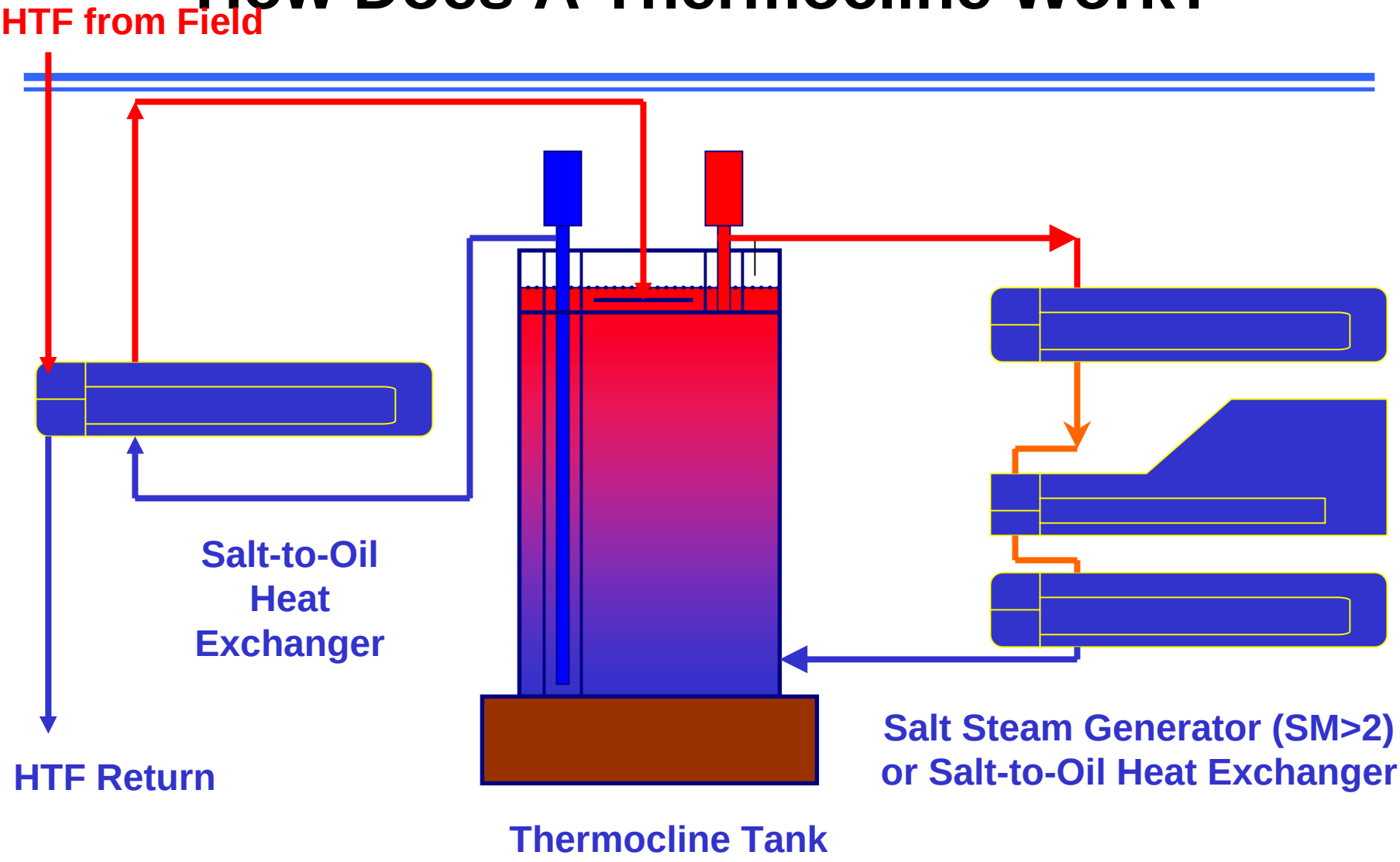
- Near-Term Storage
  - Emphasis on indirect, molten-salt systems (two tank and thermocline)
  - Development and Testing: prototype at Sandia
  - Analysis: finite difference and CFD for thermocline, annual simulations



Why Are We Interested in Molten Salt Thermocline Systems?

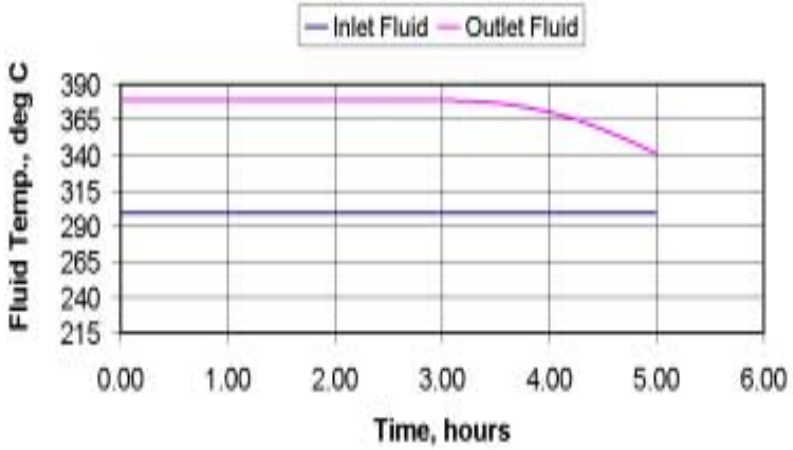
- Potentially lower cost than other options (currently $25-$35/kWh)
- Simple system design
- Compact, more efficient
- Delivers a large portion of its energy at nearly constant outlet temperature
- Experience from Solar One's thermocline
- Experience with molten salt

How Does A Thermocline Work?

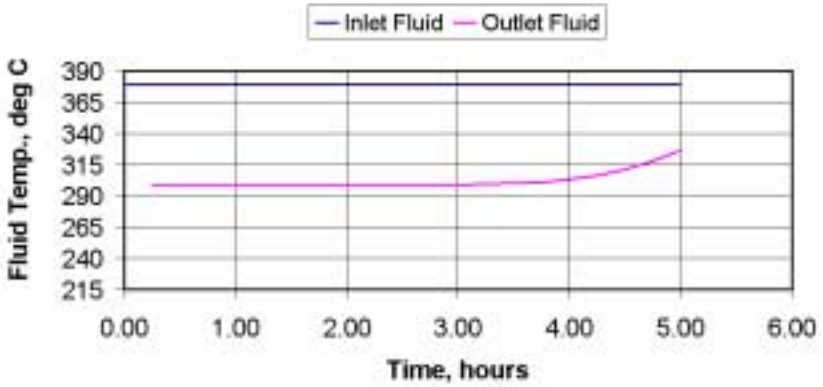


Discharging and Charging

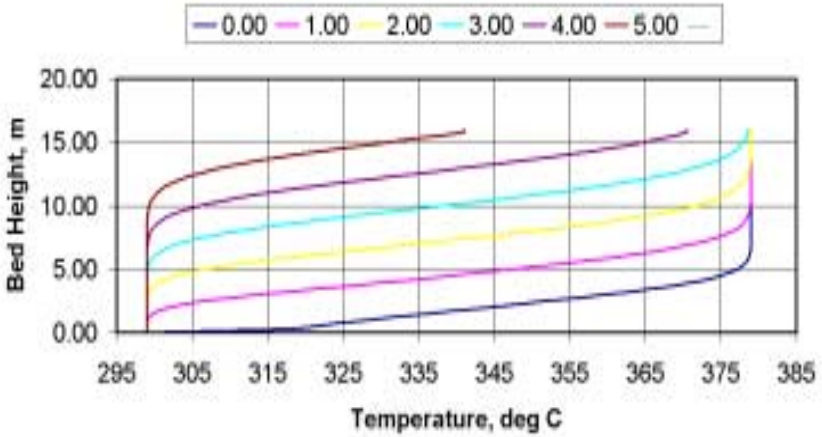
Discharging



Charging



Temperature Profiles



Candidate Filler Materials

Name	Formula
Alumina	Al2O3
Corundum*	Al2O3
Bauxite*	AlOx(OH)z
Witherite*	BaCO3
Barite*	BaSO4
Marble*	CaCO3
Fluorite*	CaF2
Anhydrite*	CaSO4
Taconite*	Fe2O3,Fe3O4
Ilmenite*	FeTiO3
Magnesite*	MgCO3
Silicon carbide	SiC
Cassiterite*	SnO2
Hydroxyapatite	Ca5(PO4)3 (OH,F,Cl)
Fluorapatite	Ca5(PO4)3(OH,F,Cl)
Limestone	CaCO3
Quartzite	SiO2

What Are the Technical Risks

- Compatibility of filler materials with molten salt
- Unproven concept
- Difficulty working with nitrate salt (freezing)
- Danger of having a fuel (Therminol) next to an oxidizer (nitrate salts)

Near-Term Thermal Storage Development Activities

- Isothermal compatibility tests
  - Objective: Evaluate potential filler materials
  - 17 candidate materials
  - Measure weight loss in nitrate salt for 1000 h
  - Analyze salt chemistry
  - Status: Complete 10h, 100h, and 1000h tests. Salt analysis partially completed.

Barite: Before and After 100 h
Witherite: Before and After 100 h
Taconite: Before and After 100 h
NM Limestone: Before and After 100 h
Quartzite: Before and After 100h

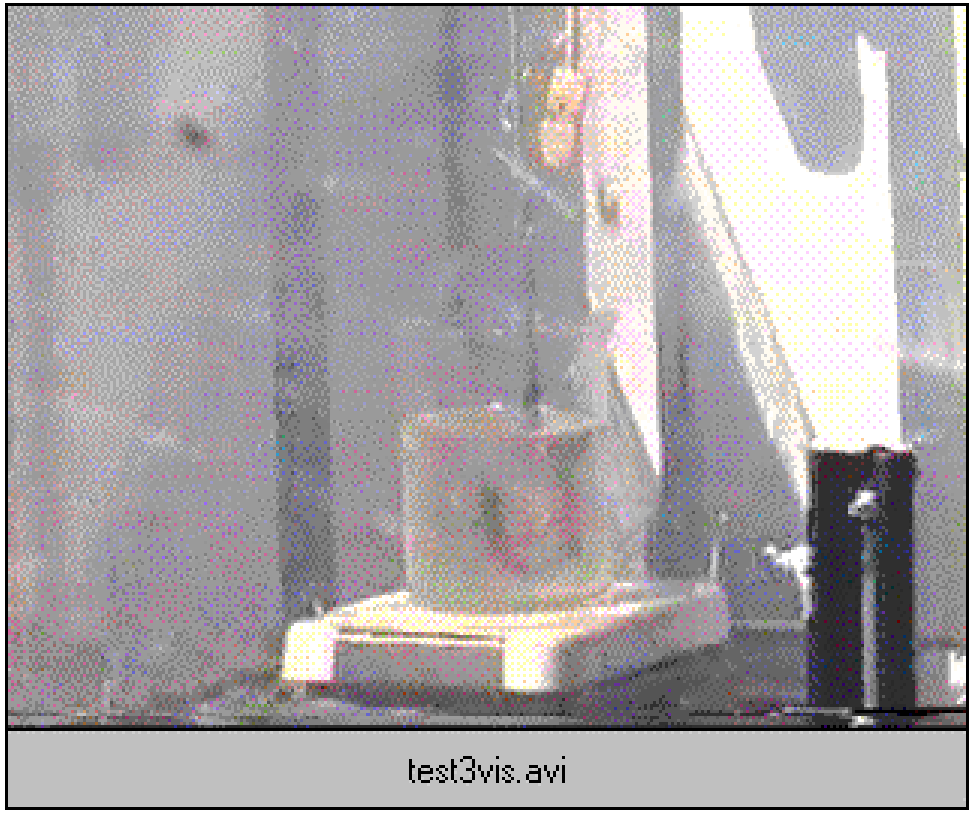
Near-Term Thermal Storage Development Activities (Continued)

- Thermal Cycling Test
  - Objective: Evaluate mechanical integrity of best candidate filler materials
  - Cycle with flowing salt between 290 C and 400 C
  - Status: Completed 360 cycles on Taconite, Limestone and Marble, 550 cycles on Quartzite.
  - Limestone did not hold up to thermal cycling.
  - Marble shows possible recrystalization.
  - Taconite and Quartzite held up well. Currently testing Silica sands.

"Hot Rocks"
Thermal Cycling System

Near-Term Thermal Storage Development Activities (Continued)

- Salt Safety Tests:
  - Objective: Evaluate reaction of Therminol oil with nitrate salt in the event of a breach of the salt-to-oil heat exchanger
  - Introduced Therminol into beaker of nitrate salt at 400 C: 1) on surface of salt, 2) below surface, 3) trapped in scintillation vial held below surface, and 4) spark above vapor tapped above salt
  - Results:
    - Therminol rapidly boiled off
    - No evidence of reaction with salt
    - Vapor ignited in test 4 (as expected



Near-Term Thermal Storage Development Activities (continued)

- Engineering-Scale Thermocline Test
  - Objective: Verify operation of a small engineering-scale thermocline (capacity, operability, temperature gradient). Compare with modeled behavior.
  - 1.5 MWh capacity (3 m diameter x 6 m tall)
  - Heat input simulated with propane heater, heat rejection with air-blast cooler
  - Filler material and salt mixture TBD
  - Status: System designed and laid out. Tank fabricated and mounted. Heater being refurbished. Cooler mounted. Piping installed. Testing planned to begin this summer.